

### **3.2 Elements of an EMS Present in 1998**

In the 1998 survey, all eight facilities that responded to the post-EMS survey indicated the presence of nearly all the elements of an EMS, as defined for this project. The following elements were not included in UTC's EMS as of 1998 (the number of facilities that did not have the specified element in place is shown in parentheses):

- Mandatory training program in place that includes EH&S policy and provides specific EH&S requirements that are conditions of employment (4)
- Documented communications plan in place for external communication of EH&S issues and information (3)
- Communication of EH&S policy to all customers (3)
- Written annual EH&S plan incorporated into the overall business plan of the operation (3)

The elements of an EMS most often missing in 1998, according to the surveys, can be grouped into two major categories: (1) incorporation of EMS policies and procedures into the overall "business plan" of the individual facility and (2) a communications plan in place for external communication of EH&S issues. Development of those elements may increase awareness of EH&S issues, both internally and externally, and may help bring about improvements in regulatory compliance and environmental performance.

### **4.0 PRESENTATION OF UTC'S COMPLIANCE STATUS AND THE ROOT AND CONTRIBUTING CAUSES OF NONCOMPLIANCE IN 1990 AND IN 1998**

This section describes the types of noncompliance identified at UTC facilities before 1990 (as indicated by the 1993 complaint and summarized by Tetra Tech in the pre-EMS profiles) and in 1998 (as indicated by the results of third-party audits conducted in 1997 and 1998 [hereafter

referred to as the 1998 audits] and summarized in post-EMS profiles completed by UTC) and identifies the root and contributing causes of such instances of noncompliance<sup>2</sup>.

The subsections that follow include information related to:

- Limitations and qualifications of the data analyzed
- Evaluation of facility compliance status for 1990 and for 1998
- Evaluation of noncompliance categories for instances of noncompliance for 1990 and for 1998
- Root and contributing causes for instances of noncompliance for 1990
- Root and contributing causes for instances of noncompliance for 1998

#### **4.1 Limitations and Qualifications**

The following limitations and qualifications apply to evaluation of noncompliance at UTC facilities and of the root causes of noncompliance:

- The analysis of the number and types of noncompliance is limited to the extent that the 1990-era inspections and the 1998 audits were conducted for different purposes. As such, these two groups of inspections are not directly comparable in scope or duration.
- The analysis of noncompliance must be qualified to the extent that the 1993 complaint addressed only instances of noncompliance with regulations under RCRA at six facilities (excluding noncompliance related to underground storage tank (UST) regulations) and the CWA at six facilities, while the 1998 audits included all eight facilities and also identified noncompliance with regulations under statutes that were not included in the inspections conducted before 1990, such as the Clean Air Act (CAA), the Emergency Planning and Community Right-to-Know Act (EPCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). However, identification of the root causes for those noncompliance events provides insight into the effect of the implementation of an EMS; therefore, the findings under the other statutes were included in the evaluation of root causes of noncompliance.
- The procedures used to determine compliance with CWA requirements differed between the 1990-era inspections and the 1998 audits. The 1990-era inspections included only a

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<sup>2</sup> Throughout the remainder of this document, (1) categories of root cause of noncompliance are shown in bold, and (2) specific root causes of noncompliance are shown in italics.

file review at six facilities, while the 1998 audits included an on-site inspection at all eight facilities.

- The analysis of noncompliance categories before and after implementation of an EMS is limited because of the manner in which noncompliance is summarized in the 1993 complaint and in the pre- and post-EMS profiles. For example, in the 1993 complaint, multiple instances of noncompliance often were consolidated in the complaint as a single violation. Therefore, in the pre-EMS surveys, multiple instances of the same types of noncompliance often were assigned a single noncompliance category. The post-EMS profiles were arranged in a similar format for consistency. This consolidation may alter the distribution of noncompliance categories between the pre-EMS and post-EMS profiles. For example, in Section 4.3 of this document, the percentage of exceedances is reported as higher (17 percent) in the post-EMS profiles than in the pre-EMS profiles (8 percent) despite a much greater number of individual exceedances (due largely to effluent violations) identified in the pre-EMS profiles as compared to the post-EMS profiles.

## **4.2 Comparative Evaluation of the Compliance Status of UTC Facilities**

This section provides an analysis of the information in the 1993 complaint and the 1999 Report of Violations, as summarized in Tetra Tech's pre-EMS profiles and UTC's post-EMS profiles. The following discussion presents a summary of the types of noncompliance identified at UTC facilities, by environmental statute. Table 3 depicts the instances of noncompliance for 1990; Table 4 shows instances of noncompliance from 1998 for RCRA and CWA, the two statutes for which there are data for both time frames. Instances of noncompliance identified in the 1993 complaint then are compared with those identified during the post-EMS compliance audits.

**Table 3**  
**Summary of Pre-EMS Noncompliance**  
 (Page 1 of 2)

<b>KEY:</b> ○ 1-5 counts ● 6-50 counts ■ >50 counts	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
<b>RCRA</b>						X <sup>3</sup>		X <sup>3</sup>
Failure to label containers	●	■	●	○	■		●	
Failure to mark containers with accumulation date	○	○	○		■		●	
Failure to close containers during use	○	○	●	○	●		●	
Inadequate contingency plan	○		○	○	○		○	
Inadequate personnel training			○	○	○		○	
Failure to minimize possibility of fire/explosion/sudden release of hazardous waste	○	○			○			
Accumulation of hazardous waste for more than 90 days	○		○	●	○		●	
Failure to make hazardous waste determination			○	○	○		●	
Failure to maintain adequate security				○	○			
Failure to inspect hazardous waste storage tank				○				
Failure to report spill incident	○							
Failure to manage containers to prevent ruptures/leaks	○				■			
Inadequate waste analysis plan		○	○	○	○			
Failure to maintain adequate aisle space	○		○		○		○	
Poor container condition	○				○			
Inadequate operating record					○			
Inadequate groundwater monitoring					○		○	
Inadequate inspections			○	○	○			

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Compliance with requirements under RCRA were not reviewed at the P&W Rocky Hill or UTRC facilities as part of the original action.

**Table 3**  
**Summary of Pre-EMS Noncompliance**  
 (Page 2 of 2)

	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
Failure to separate incompatible wastes			○	○	○		●	
Improper storage of hazardous waste in waste piles			○					
Closure plan violations			○					
Land disposal restrictions (LDR) notices - failure to make determinations/send and retain notices	○		●		●		●	
LDR - incorrect notices	●	○		○			■	
Violation of export requirements	●		○				●	
<b>CWA</b>		X <sup>4</sup>					X <sup>4</sup>	
Unauthorized discharge	○		●	●		○		○
Flow volume exceedances				■				
Effluent limitation violations	■		■	○	●	●		
Violation of reporting requirements - direct discharges	■					○		
Violations of national categorical standards for metal finishers	○							
Violations of national pretreatment standards (pH)	○							
Violation of reporting requirements-indirect discharges	■							

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Compliance with requirements of the CWA were not reviewed at the Pratt & Whitney, Colt Street, or Sikorsky Stratford facilities as part of the original action.

**Table 4**  
**Summary of Post-EMS Noncompliance**  
 (Page 1 of 3)

<b>KEY:</b> ○ 1-5 counts ● 6-50 counts ■ >50 counts	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
<b>RCRA<sup>5</sup></b>								
Failure to label containers	○		○	○				
Failure to mark containers with accumulation date	○							
Failure to close container during use								○
Inadequate contingency plan								○
Inadequate personnel training	○							
Failure to provide access to internal alarm or communication device	○							
Late annual report					○			
Failure to notify of increase in waste quantity					○			
Failure to include all required information on a manifest (export requirements and signature)			○	○				
Failure to maintain adequate aisle space		○		○				
Failure to submit accurate annual report on export activities		○		○				
Failure to file an exception report				○				○
Failure to submit a report on groundwater monitoring activities		○						
Failure to inspect container accumulation areas weekly			●			●		
Failure to inspect containment building weekly			○					
Failure to conduct daily inspections of loading/unloading areas					●			

<sup>5</sup> All facilities were audited under RCRA. These audits included evaluation of compliance with UST requirements.

**Table 4**  
**Summary of Post-EMS Noncompliance**  
 (Page 2 of 3)

	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
Failure to inspect evacuation alarm			○					
Failure to amend contingency plan			○	○	○			
Failure to conduct tank integrity assessments							○	
<b>CWA<sup>6</sup></b>								
Unauthorized discharge (photo processing wastewater)							○	
Flow volume exceedance								○
Effluent limitation violations	●			●	○		●	●
Violation of reporting requirements-direct discharges				○	○			○
NPDES permit excursion						●		
BMP does not address all that is required					○			
Failure to identify and sample stormwater discharges			○					
Aquatic toxicity violation for stormwater discharge		○			●			
Incorrect flow rate					○			
Failure to prevent avoidable by-pass			○	○				

<sup>6</sup> Note: All facilities were audited on site under the CWA in the 1998 audits, and the audits included the stormwater program, which did not exist at the time of the 1990-era inspections.

**Table 4**  
**Summary of Post-EMS Noncompliance**  
 (Page 3 of 3)

	Hamilton Sundstrand Windsor Locks	Pratt & Whitney Colt Street	Pratt & Whitney East Hartford	Pratt & Whitney Middletown	Pratt & Whitney North Haven	Pratt & Whitney Rocky Hill	Sikorsky Stratford	United Technologies Research Center
Improper signature/no signature to NPDES permit application							○	
Total chromium limit violation							○	
Failed to include evaluation of roof emissions on site runoff/SWPPP	○							
No pH records for discharges	●							
Failure to describe stormwater management controls (7,000 gallon H <sub>2</sub> SO <sub>4</sub> tank)		○						
Failure to conduct stormwater inspections			●	○				
Failure to maintain records of stormwater inspections							●	
Good housekeeping practices for stormwater not followed				○				
Failure to maintain adequate DMR records							○	
Failure to cover equipment (dumpsters)				○			○	
Failure to perform evaluation for need for cover for stormwater control				○				
Failure to conduct annual monitoring of stormwater outfall/missing element							○	
SWPPP does not reflect actual conditions				○				
UST records not available				○				
Missed transformer and bulk tank inspections				●				



## **RCRA**

The types of noncompliance with RCRA identified in the 1993 complaint generally were not identified in the post-EMS profiles. Exceptions include (the number of facilities for which specific instances of noncompliance were identified is listed in parentheses):

- Failure to label containers holding hazardous wastes (2)
- Failure to mark containers holding hazardous waste with the initial accumulation date (1)
- Failure to conduct weekly inspections of container accumulation areas (2)

Although most of the noncompliance in the 1993 complaint appears to have been addressed, as indicated by the 1998 compliance audits, several additional (new) instances of noncompliance were identified in the post-EMS compliance audits. The most common of those new instances of noncompliance include (the number of facilities at which the specific instance of noncompliance was identified is listed in parentheses):

- Inadequate aisle space (3)
- Failure to amend the contingency plan (3) (as compared to inadequate contingency plan in 1990)
- Noncompliance with requirements governing amounts of hazardous waste exported (2)

Figure 2 shows the total number of findings of noncompliance under RCRA per type of noncompliance. Figures 3 and 4 show similar information about RCRA violations for the

Overall, the total number of instances of noncompliance with RCRA regulations dropped substantially between the pre-EMS inspections and the post-EMS audits.

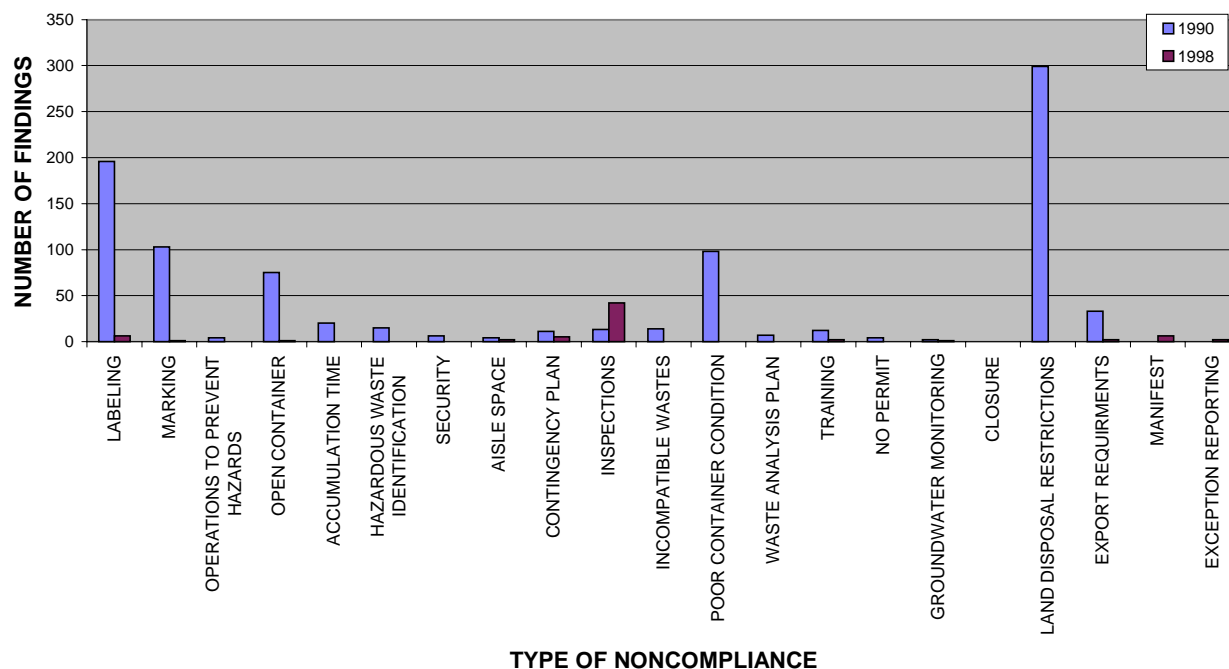
P&W North Haven and P&W East Hartford facilities.<sup>7</sup> As the figures show, the 1990 findings of the RCRA inspections showed more instances of noncompliance with RCRA regulations that applied to the participating UTC facilities than did the 1998 audits. The 1998 audits performed

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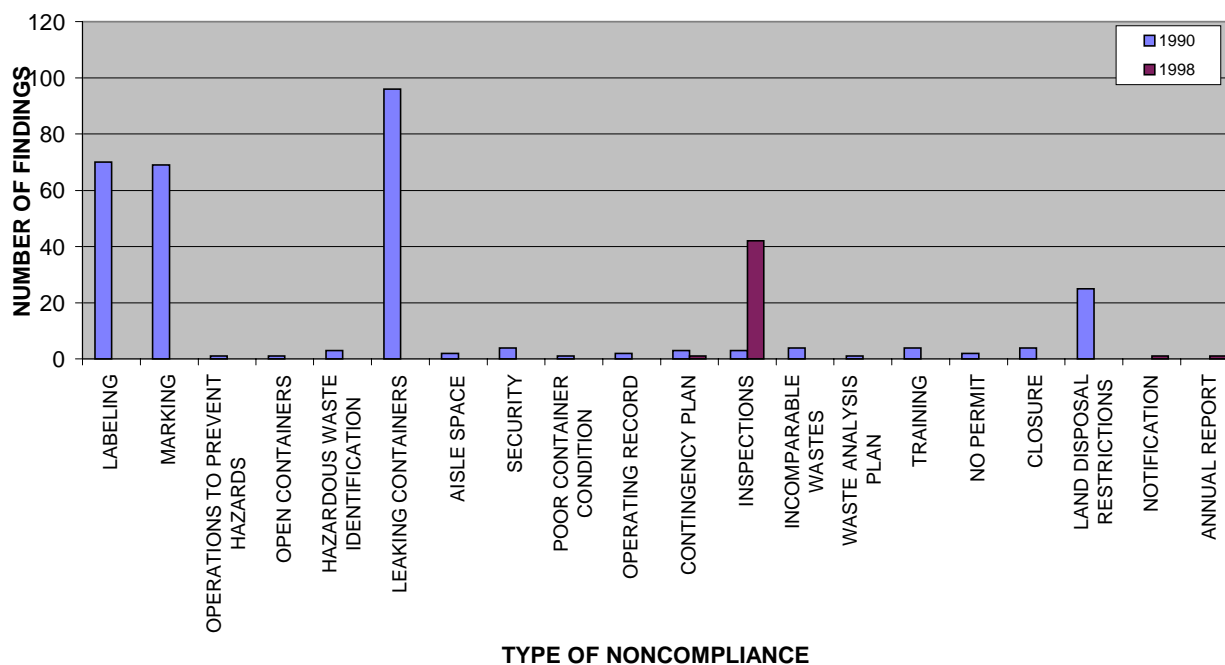
<sup>7</sup> In some instances, figures 2, 3, and 4 include similar violations that have been grouped together for ease of analysis and presentation. For example, the violation “failure to amend the contingency plan” is included in a broader category of “contingency plan,” which also may include violations such as “inadequate contingency plan.”

after implementation of EMSs at the facilities show a comparatively smaller number of violations, several of which are fairly minor in nature, such as missing signatures on a manifest.

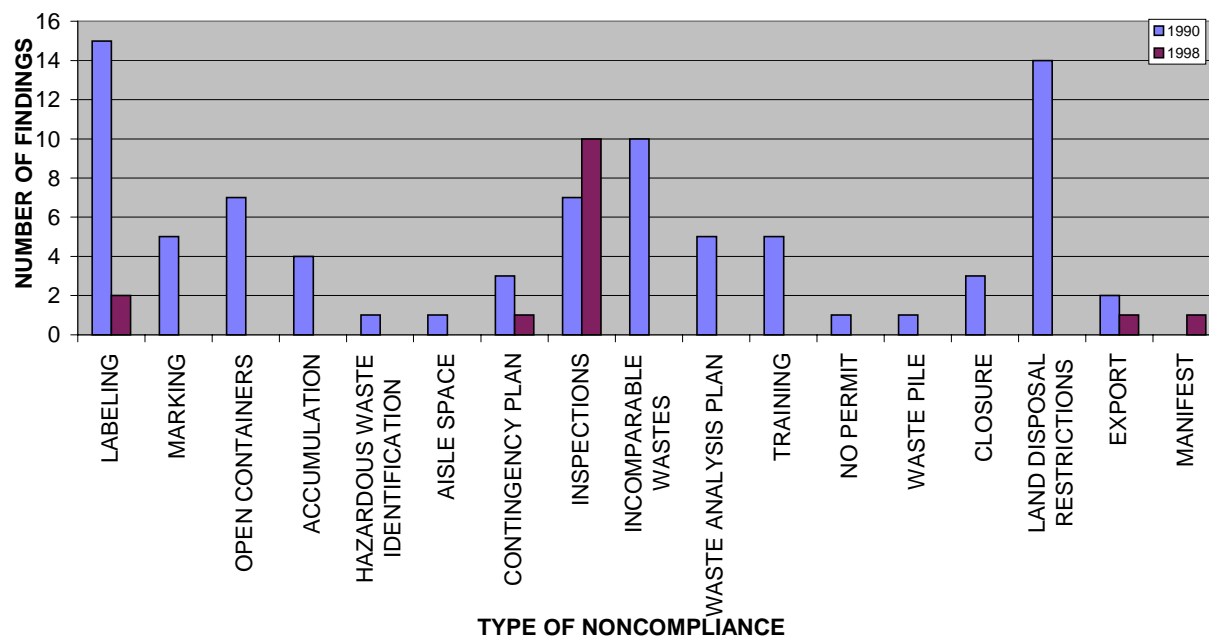
**Figure 2. RCRA Noncompliance: 1990 vs. 1998**



**Figure 3. P&W North Haven - RCRA Noncompliance**



**Figure 4. P&W East Hartford - RCRA Noncompliance**



The audits in 1998 more commonly found less extensive problems within program areas, such as failure to inspect an alarm when performing weekly inspections at hazardous waste accumulation areas.

As the figures indicate, there generally has been significant improvement, based on the total numbers of instances of noncompliance, in the participating UTC facilities' ability to attain compliance with RCRA regulations. Post-EMS violations also tend to be more minor in nature than those that led to the complaint.

## CWA

Instances of noncompliance with CWA regulations identified in the 1993 complaint generally are related to items identified through records reviews, mainly: (1) effluent violations (at five facilities) related to parameters specified in the National Pollutant Discharge Elimination System (NPDES) permits issued to the participating UTC facilities or (2) unauthorized discharges to surface water (at four facilities). Several types of noncompliance that had not appeared in the

complaint were identified in the audits which were performed on-site in 1998. Examples of common types of noncompliance identified in the complaint include (the number of facilities at which the violation was identified appears in parentheses):

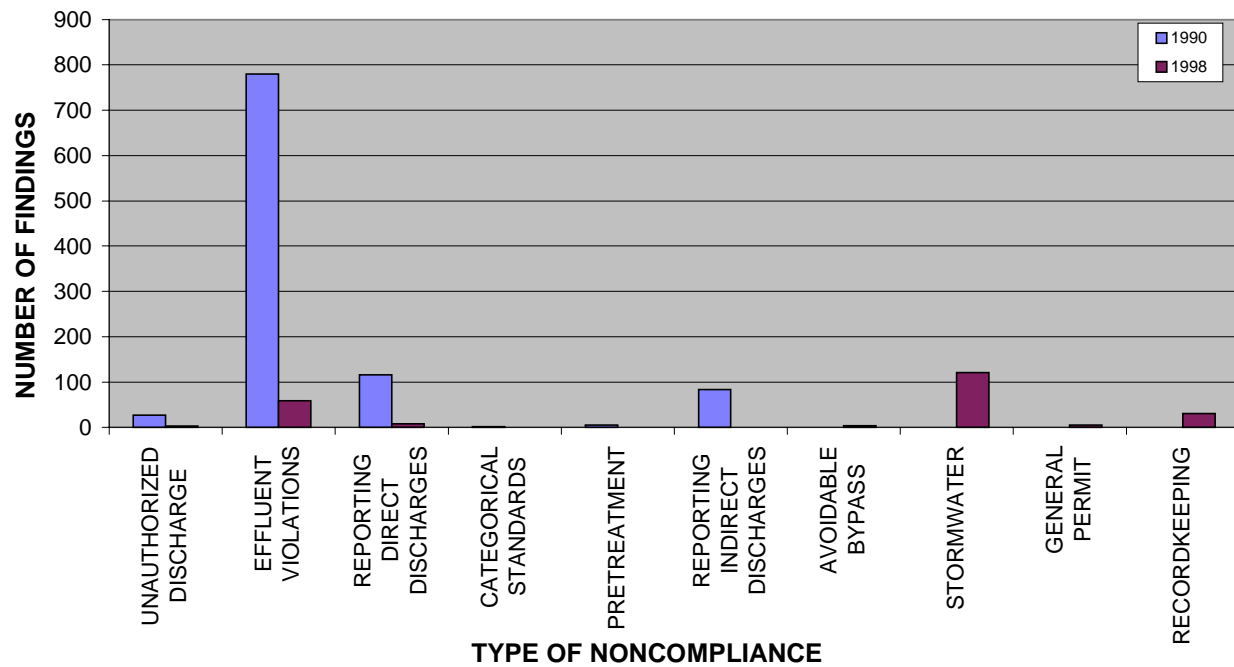
- Violations of effluent limits on for pH (5), oil and grease (2), total suspended solids (TSS) (2), chlorine (1), fluoride (1), hexavalent chromium (1), and aquatic toxicity and metals (1)
- Failure to report effluent violations or permit exceedances (3)
- Failure to conduct inspections (3)
- Failure to prevent an avoidable by-pass (2)
- Unauthorized stormwater outfalls (2)
- Failure to cover equipment (2)
- Failure to maintain records of inspections (2)

Figure 5 shows the total number of instances of noncompliance with CWA requirements identified for 1990 and for 1998, sorted by the type of noncompliance. Figures 6 and 7 show similar information for the P&W East Hartford and the Hamilton Sundstrand facilities.<sup>8</sup>

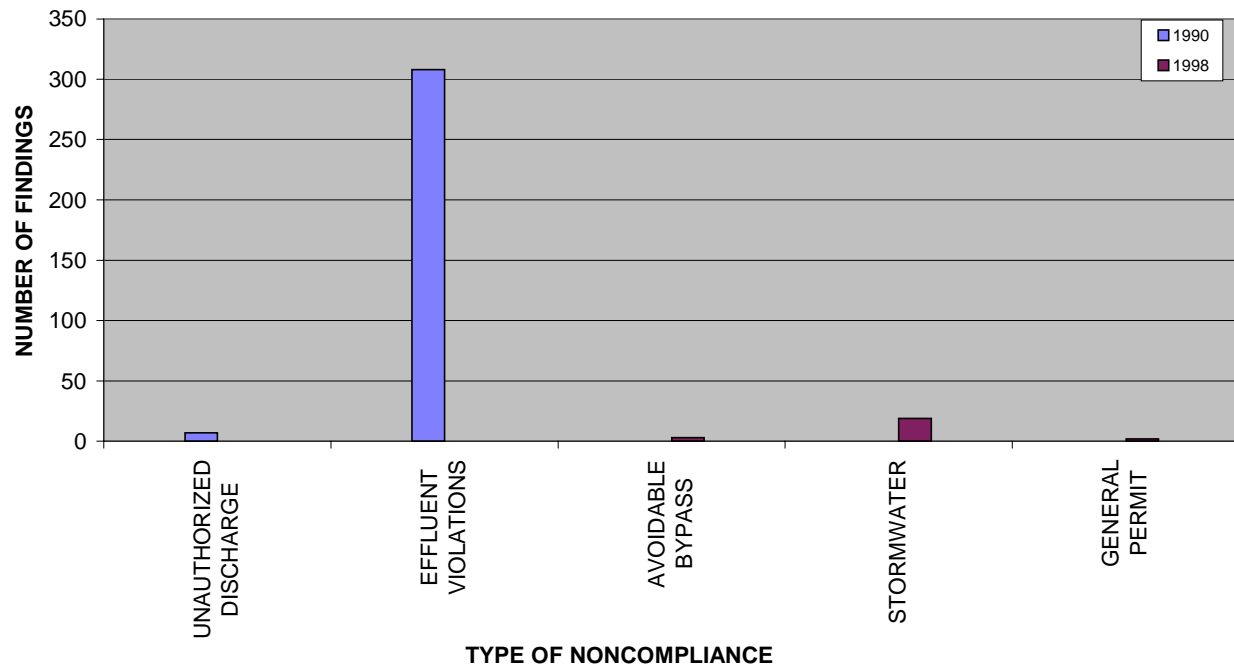
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<sup>8</sup> As with figures 2, 3, and 4 above (summarizing RCRA violations), figures 5, 6, and 7 include similar violations that have been grouped together for ease of analysis and presentation.

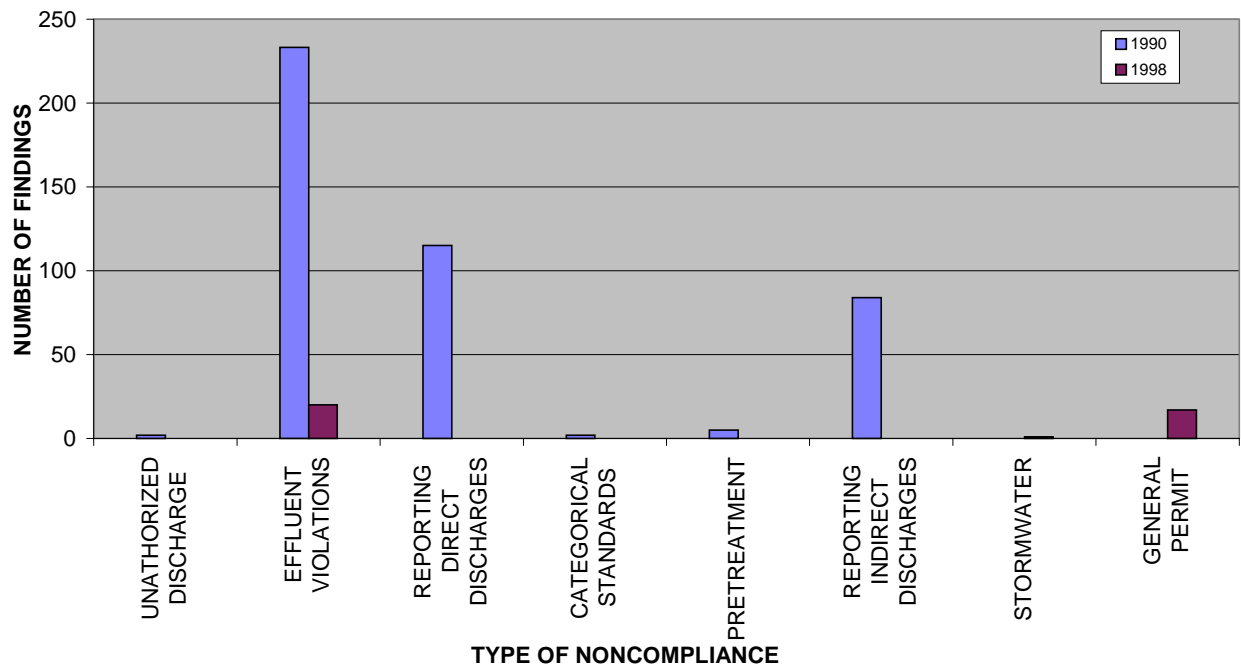
**Figure 5. Comparison of Noncompliance with the CWA in 1990 vs. 1998**



**Figure 6. Noncompliance with the CWA at P&W East Hartford**



**Figure 7. Noncompliance with the CWA at Hamilton Sundstrand**



As can be seen in the figures, instances of noncompliance of regulations under the CWA in 1990 included over 700 effluent violations. The auditors who performed the 1998 follow-up audits after implementation of the EMSs found a much smaller number (fewer than 50) of

As with the finding about noncompliance under the RCRA program, the overall number of instances of noncompliance with CWA requirements dropped substantially from the time of the pre-EMS inspections and that of the post-EMS audits and the post-EMS violations tended to be more minor in nature.

similar violations. Similarly, more than 300 effluent limitation violations were identified at the P&W East Hartford facility in 1990, while none of those violations were noted in 1998.

Under the CWA, the majority of the 1998 instances of noncompliance occurred under the stormwater program for which regulations were issued after UTC began implementing EMSs at their participating facilities. Thus it is not possible to compare compliance with the stormwater program's requirements before and after implementation of an EMS. The existence of the

noncompliance with stormwater regulations in 1998 does, however, highlight the need to update an EMS to keep pace with changing regulations.

### ***CAA, CERCLA and EPCRA***

During the 1990 inspections, participating UTC facilities were not evaluated for compliance with requirements of the CAA, CERCLA or EPCRA. Therefore, no violations of those requirements are represented in the pre-EMS profiles. During the 1998 audits, the facilities were evaluated for compliance with regulations under all environmental statutes. At some of the facilities, some violations of the requirements of the CAA, CERCLA and EPCRA were identified in the post-EMS profiles. At two facilities, third-party auditors identified noncompliance issues under the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations related to the disposal of asbestos. At one facility a monitoring and recordkeeping NESHAP violation was identified. Noncompliance with requirements under the CAA Title 5 permitting program was identified at another facility. The post-EMS profile indicated a failure to report continuous releases of nitrogen oxides (NO<sub>x</sub>) at one facility. Under EPCRA, three facilities were found to have failed to submit Tier II forms, and one facility failed to identify all storage locations on a Tier II form and to report all uses of a toxic chemical (methanol) on a Form R.

### **4.3 Evaluation of Noncompliance Categories for 1990 and 1998**

Tetra Tech analyzed the pre- and post-EMS profiles by examining the relative number of types of noncompliance categories as defined in the survey. As mentioned in Section 4.1, it should be noted that the individual findings of similar types of noncompliance were consolidated in the pre- and post-EMS profiles. For example, multiple findings of noncompliance with RCRA labeling requirements for hazardous waste containers, CWA exceedences under NPDES permits, and similar multiple violations were assigned a single noncompliance category for purposes of analysis. For a more detailed discussion of the relative numbers of instances of noncompliance at participating UTC facilities for the pre-EMS and post-EMS timeframes, the reader should refer to Section 4.2 of this document.

The noncompliance categories identified most frequently in the pre-EMS profiles were (the percentage of times cited is listed in parentheses):

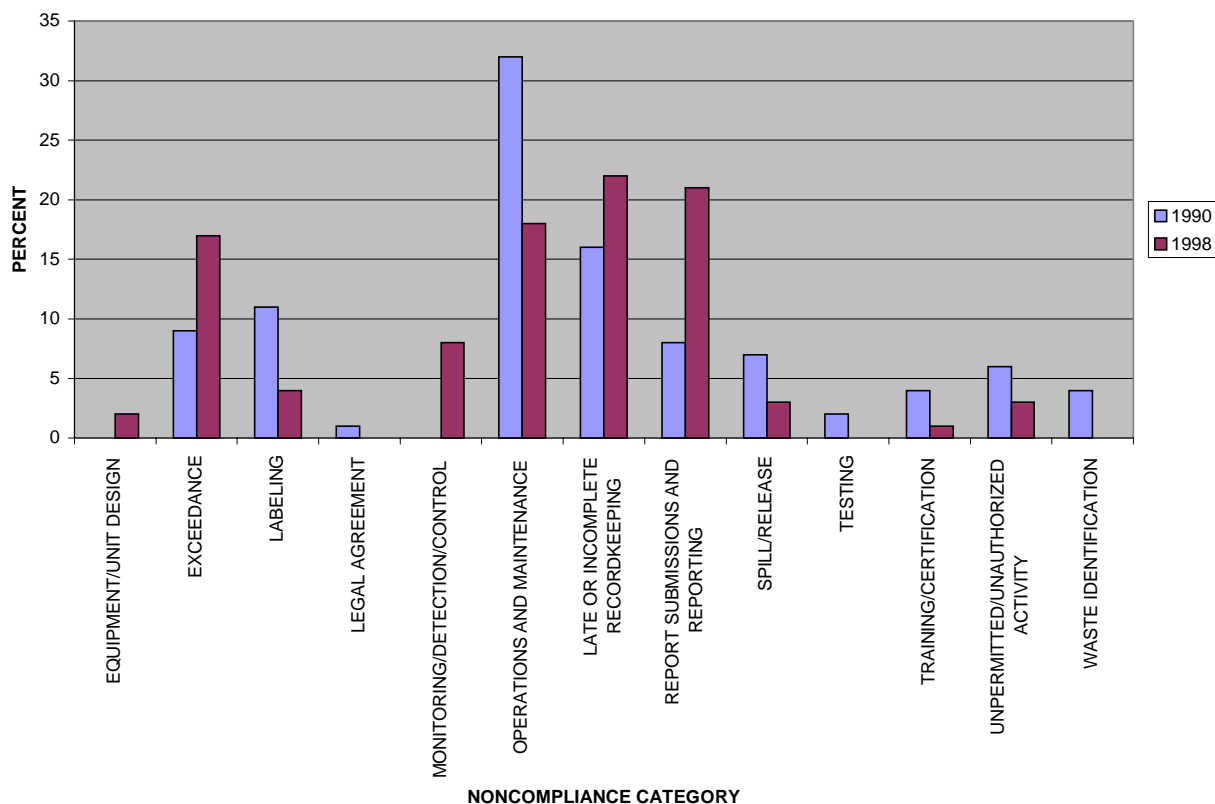
- Operations and maintenance (32 percent)
- Late or incomplete recordkeeping (16 percent)
- Labeling (11 percent)

The noncompliance categories most frequently identified in the post-EMS profiles were:

- Late or incomplete recordkeeping (23 percent)
- Report submissions and reporting (21 percent)
- Operations and maintenance (18 percent)
- Exceedances (17 percent)

Figure 8 is a bar graph that allows comparison of the distribution of the noncompliance categories in 1990 and in 1998. The root and contributing causes of noncompliance related to each of the noncompliance categories are discussed in greater detail below.

**Figure 8. Distribution of Noncompliance by Category - 1990 and 1998**





## *Operations and Maintenance*

For the pre-EMS profiles, operations and maintenance (O&M) was identified as a noncompliance category twice as often as any other category, accounting for 32 percent of the instances of noncompliance identified, while the category accounted for only 18 percent of the instances of noncompliances identified after implementation of the EMS.

**Root Cause:** The category of root cause of noncompliance related to O&M most frequently identified in pre-EMS surveys (34 percent) was **Management**, while **Procedures** was the second most frequently cited root cause (24 percent). The root cause category cited most frequently in the post-EMS surveys was **Human Error** (45 percent), a significant change from the citations in pre-EMS surveys, in which **Human Error** was identified as a root cause category only 6 percent of the time.

Although **Procedures** was the second most frequently cited root cause category for noncompliance related to O&M in both the pre- and post-EMS surveys the two sets of surveys differ in the specific root causes identified in the **Procedures** category. In general, before the

This demonstrates a shift in root causes after implementation of the EMS, from large gaps in EMS (no operating procedures) to more focused areas in which improvement is needed, such as the implementation of existing procedures.

implementation of an EMS, the specific root cause cited in the **Procedures** category was most often “*no written operating procedures available.*” After implementation of an EMS the specific root cause most frequently was identified as “*operating procedure not followed.*”

The remaining 42 percent of the categories of root causes of noncompliance identified in the pre-EMS surveys by UTC facilities included (in descending frequency of citation): **Policy, Training, Human Error, Compliance Monitoring, Regulations and Permits, and Equipment Problems.** In the post-EMS surveys, the remaining categories are **Compliance Monitoring, Emergency Preparedness, Communications, and Management.** **Management** was a leading

category of root cause cited in the pre-EMS surveys, while it played a only minor role as a root cause category after implementation of an EMS. However, **Management** was cited as a major contributing cause category in the post-EMS surveys. The pre- and post-EMS surveys differed in the specific cause within the category of **Management** each set of surveys identified. In the pre-EMS surveys, specific root cause was identified as “*no formal management structure to address noncompliance and follow-through,*” while in the post-EMS surveys, the specific contributing cause under the **Management** category was identified as “*staffing at an inappropriate level or expertise.*”

**Contributing Cause:** The most frequently cited categories of contributing causes of noncompliance for violations related to O&M (percentage of time cited shown in parenthesis) were:

<u>Pre-EMS Contributing Cause</u>	<u>Post-EMS Contributing Cause</u>
<ul style="list-style-type: none"> <li>• <b>Compliance Monitoring</b> (28 percent)</li> <li>• <b>Management</b> (24 percent)</li> <li>• <b>Human Error</b> (17 percent)</li> <li>• <b>Training</b> (13 percent)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Management</b> (24 percent)</li> <li>• <b>Procedures</b> (24 percent)</li> <li>• <b>Compliance Monitoring</b> (14 percent)</li> <li>• <b>Regulations and Permits</b> (10 percent)</li> <li>• <b>Communications</b> (10 percent)</li> </ul>

Other categories of contributing causes of noncompliance for O&M violations related to O&M before implementation of an EMS included **Communication, Procedures, Regulations and Permits, Policies, and Equipment Problems**. Similar categories for the post-EMS period included **Human Error, Emergency Preparedness, Equipment, and Training**.

Keeping in mind that respondents could cite as many contributing causes as they felt applied, the second most frequently cited contributing cause for the O&M category in the pre-EMS surveys (after **Compliance Monitoring** where the specific cause most commonly was “*audit program insufficient*”) is **Management**, which is tied with **Procedures** for the most frequently cited contributing cause in the post-EMS surveys. The specific contributing cause most often cited was “*staffing-inappropriate level or expertise*” (cited 9 times in the pre-EMS survey and 5 times

in the post EMS survey) whereas the specific contributing cause of “*management support or guidance not provided*” was cited 9 times in the pre-EMS survey and not at all in the post-EMS survey. This may demonstrate that lack of management support and guidance may have contributed substantially to noncompliance in the pre-EMS timeframe.

### *Late or Incomplete Recordkeeping*

Late or incomplete recordkeeping was the major category of noncompliance cited in the post-EMS profiles, accounting for 23 percent of the incidents of noncompliance identified. In the pre-EMS profiles, late or incomplete recordkeeping accounted for 16 percent of the incidents of noncompliances identified. The categories of root causes of noncompliance related to late or incomplete recordkeeping that were cited in the two sets of surveys were (the percentage of times each category of root cause was identified is listed in parentheses):

<u>Pre-EMS Root Cause</u>	<u>Post-EMS Root Cause</u>
<ul style="list-style-type: none"> <li>• <b>Procedures</b> (28 percent)</li> <li>• <b>Management</b> (24 percent)</li> <li>• Other (48 percent), including <b>Compliance Monitoring, Communication, Human Error, Emergency Preparedness, and Regulations and Permits</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Regulations and Permits</b> (41 percent)</li> <li>• <b>Procedures</b> (25 percent)</li> <li>• <b>Human Error</b> (16 percent)</li> <li>• Other (18 percent), including <b>Management, Communication and Compliance Monitoring</b></li> </ul>

The principal root cause category for noncompliance in the category of late or incomplete recordkeeping has changed since implementation of EMSs at participating UTC facilities from **Procedures** to **Regulations and Permits**. In general, in the post-EMS surveys, the specific root cause was identified as “*ambiguous federal regulations*” and “*ambiguous state regulations.*” As in the case of noncompliance related to O&M, **Procedures** was cited as a root cause category in both the pre-EMS and post-EMS surveys. However, again, the specific root cause in the **Procedures** category has changed from “*no written operating procedures*” (pre-EMS) to “*operating procedures were not followed*” (post-EMS). This demonstrates a shift from more

widespread root causes (lack of procedures) to more intractable root causes attributable to the actions of individuals.

The categories of contributing causes of noncompliance related to late or incomplete recordkeeping are (percentage of times cited in parenthesis):

<u>Pre-EMS Contributing Cause</u>	<u>Post-EMS Contributing Cause</u>
• <b>Compliance Monitoring</b> (33 percent)	• <b>Procedures</b> (30 percent)
• <b>Management</b> (30 percent)	• <b>Human Error</b> (26 percent)
• <b>Regulations and Permits</b> (22 percent)	• <b>Compliance Monitoring</b> (16 percent)

There is little similarity in contributing causes between pre and post-EMS survey results for incomplete recordkeeping. Other categories of contributing cause of noncompliance that were identified in the pre-EMS surveys include **Human Error**, **Training**, and **Procedures**. Less frequently cited contributing categories of noncompliance in the post-EMS surveys were **Management**, **Communication**, and **Regulations and Permits**.

#### *Report Submissions and Reporting*

Report submissions and reporting accounted for 21 percent of the incidents of noncompliance cited in the post-EMS profiles, in contrast to only eight percent of such citations in the pre-EMS profiles. The categories of root causes of noncompliance related to report submissions and reporting identified in the two sets of surveys include (the percentage of times each category of root cause was identified is listed in parentheses):

<u>Pre-EMS Root Cause</u>	<u>Post-EMS Root Cause</u>
• <b>Management</b> (38 percent)	• <b>Human Error</b> (31 percent)
• <b>Compliance Monitoring</b> (25 percent)	• <b>Procedures</b> (23 percent)
• <b>Procedures</b> (19 percent)	• <b>External Circumstances</b> (15 percent)
• <b>Human Error</b> (13 percent)	• <b>Regulations and Permits</b> (15 percent)
• <b>Regulations and Permits</b> (6 percent)	• Other (15 percent), including <b>Compliance Monitoring</b> and <b>Communication</b>

As in the cases of O&M and the late or incomplete recordkeeping, **Management** was the most frequently identified category of causes of noncompliance attributed to Report Submissions and Reporting identified in the pre-EMS surveys. An evaluation of specific root causes of noncompliance related to report submissions and reporting in the pre-EMS surveys indicates that noncompliance resulted primarily from “*no formal management structure to address noncompliance and follow-through*” and “*staffing - inappropriate level or expertise.*”

Unlike the O&M and recordkeeping categories, **Human Error** was the most frequently cited root cause category for noncompliance related to Report Submissions and Reporting identified in the post-EMS surveys. The specific root cause of

In general, the findings are consistent with findings about the categories of noncompliance discussed earlier: noncompliance in the post-EMS period seems to primarily be associated with failure to implement established procedures correctly.

noncompliance most frequently identified was “*individual responsibility or professional judgment.*” The next most common specific root causes of noncompliance identified included “*operating procedures not followed*” and “*contracted services, such as haulers and handlers.*”

The categories of contributing causes of noncompliance related to Report Submissions and Reporting identified in the two sets of surveys include:

- | <u>Pre-EMS Contributing Cause</u>           | <u>Post-EMS Contributing Cause</u>           |
|---|--|
| • <b>Compliance Monitoring</b> (20 percent) | • <b>Compliance Monitoring</b> (24 percent)  |
| • <b>Management</b> (20 percent)            | • <b>Human Error</b> (18 percent)            |
| • <b>Human Error</b> (15 percent)           | • <b>Procedures</b> (18 percent)             |
| • <b>Training</b> (15 percent)              | • <b>External Circumstances</b> (12 percent) |
| • <b>Procedures</b> (15 percent)            | • <b>Communications</b> (12 percent)         |

The specific contributing causes under **Compliance Monitoring** for both pre-EMS and post-EMS surveys included “*routine site and equipment compliance checks not conducted*”, however “*audit program insufficient*” was cited as a specific cause only in the pre-EMS surveys.

Other contributing causes identified in the pre-EMS surveys include **Regulations and Permits** and **Management**. The category of **Regulations and Permits** also was identified as a contributing cause of noncompliance in the post-EMS surveys.

### *Exceedances*

Exceedances accounted for a greater proportion of the noncompliances identified in the post-EMS profiles (17 percent) than in the pre-EMS profiles (8 percent). The categories of root causes of noncompliance related to exceedances that were identified in the two sets of surveys include (the percentage of times each category of root cause was identified is listed in parentheses):

<u>Pre-EMS Surveys Root Cause</u>	<u>Post-EMS Surveys Root Cause</u>
• <b>Management</b> (35 percent)	• <b>Equipment/Problems</b> (30 percent)
• <b>Human Error</b> (24 percent)	• <b>Management</b> (17 percent)
	• <b>Process Upset or Failure</b> (13 percent)
	• <b>Regulations and Permits</b> (13 percent)

For noncompliance related to exceedances, **Management** plays a key role, as indicated by the responses to both the pre-EMS and the post-EMS survey, ranking as the number one and number two most frequently cited root cause category, respectively. A review of the specific root causes, however, shows a change between the pre- and post-EMS surveys. In the pre-EMS surveys, the specific cause “*no formal management structure to address noncompliance and follow-through*” accounted for a total of 29 percent of all root causes. Identification of this specific root cause may indicate a lack of attention on the part of management to environmental compliance obligations before implementation of an EMS. By contrast, the specific root causes in the general root cause category of management for exceedances cited most frequently in the post-EMS survey was “*environmental aspects of facility process and operations not identified.*” Identification of the specific root cause, “*no formal management structure to address noncompliance and follow-through*” fell to four percent of the responses.

There were other specific root causes that were identified frequently in the pre-EMS surveys such as “*employee not trained*” (**Training** root cause category) and “*audit program insufficient*” (**Compliance Monitoring** root cause category) each accounting for 12 percent of the root causes, that might also be associated with lack of structured management systems.

In contrast to the pre-EMS results for the exceedance noncompliance category, root causes associated with facility processes (**Equipment Problems** and **Process Upset or Failure**) together account for 43 percent of the noncompliance related to exceedances identified in the post-EMS surveys. Some specific root causes included in these results included: “*design or installation,*” “*equipment maintenance*” and “*other.*”

Root cause categories other than those described above that were identified for exceedances in the pre-EMS surveys included **External Circumstances** and **Regulations and Permits**. Other root cause categories identified in the post-EMS surveys included **Human Error, Communications, Procedures, and Policies**.

The categories of contributing causes of noncompliance related to exceedances that were identified in the two sets of surveys included:

<u>Pre-EMS Contributing Cause</u>	<u>Post-EMS Contributing Cause</u>
• <b>Compliance Monitoring</b> (35 percent)	• <b>Management</b> (27 percent)
• <b>Management</b> (30 percent)	• <b>Policies</b> (27 percent)
• <b>Equipment Problems</b> (15 percent)	• <b>Regulations and Permits</b> (13 percent)
• <b>Procedures</b> (10 percent)	• <b>Procedures</b> (13 percent)

Other categories of contributing causes of noncompliance identified in the pre-EMS surveys included **Communication** and **External Circumstances**.

In findings similar to those related to the **Management** root cause category, the specific causes in the **Management** contributing cause category identified in the pre-EMS surveys varied widely

and included “*no formal management structure to address noncompliance and follow-through,*” “*environmental aspects of facility process and operations not identified*”, “*control and oversight not provided or not adequate*”, “*management support or guidance not provided*”, and “*management organization not defined,*” while the *specific* contributing cause cited most frequently in the general category of **Management** for exceedances in the post-EMS surveys was, as noted, “*environmental aspects of facility process and operations not identified.*”

### *Labeling*

More than 10 percent of instances of noncompliance identified in the pre-EMS profiles involved labeling, while fewer than five percent of the incidents identified in the post-EMS profiles fall into that category. The categories of root causes of noncompliance related to labeling that were identified in the pre-EMS and post-EMS surveys include (the percentage of times each category of root cause was identified is listed in parentheses):

<u>Pre-EMS Root Causes</u>	<u>Post-EMS Root Causes</u>
• <b>Management</b> (41 percent)	• <b>Procedures</b> (75 percent)
• <b>Procedures</b> (33 percent)	• <b>Human Error</b> (25 percent)
• <b>Training</b> (15 percent)	
• Other (11 percent), including <b>Human Error</b> and <b>Regulations</b> and <b>Permits</b>	

Again, **Management** is the predominant root cause category in the pre-EMS surveys, specifically, “*no formal management structure to address noncompliance and follow-through.*” Although **Procedures** accounts for a high percentage of responses in both pre- and post-EMS surveys, as the general root cause category applicable to noncompliance related to labeling, a more thorough evaluation of the specific root causes of noncompliance shows a distinct difference between the two sets of surveys in the types of specific root causes identified.



- In the pre-EMS surveys, the most frequently cited specific root causes were as follows (percentages of the times cited are shown in parentheses): “*definition of roles and responsibilities unclear*” (15 percent), “*difficulty in relating operating procedures to actual facility operations and products*” (7 percent), “*operating procedures not followed*” (7 percent), and “*no written operating procedures available*” (4 percent).
- In the post-EMS surveys, the only specific root cause related to **Procedures** was “*operating procedures not followed*” (75 percent of responses). In the remaining 25 percent of responses, which fell into the general category of **Human Error**, the specific root cause of noncompliance related to labeling was “*individual responsibility or professional judgment.*”

The information presented above suggests that noncompliance associated with labeling during the period covered by the pre-EMS surveys was primarily the result of the lack of operating procedures or the inadequacy of such procedures. In contrast, evaluation of the specific root cause identified in the post-EMS surveys indicates that noncompliance associated with labeling is the result of human error and the failure to adhere to existing procedures.

The categories of contributing causes of noncompliance related to labeling that were identified in the two sets of surveys include:

#### Pre-EMS Contributing Causes

- **Management** (35 percent)
- **Compliance Monitoring** (32 percent)
- **Human Error** (10 percent)
- Other (23 percent), including **Training, Communications, and Procedures**

#### Post-EMS Contributing Causes

- **Training** (50 percent)
- **Human Error** (25 percent)
- **Procedures** (25 percent)

**Management** was identified as the leading category of both root and contributing cause for noncompliance related to labeling in the pre-EMS surveys, but was not identified as such in the post-EMS surveys. Generally, the specific root cause was “*no formal*

The change in the distribution of the **Management** cause category between the pre-EMS and post-EMS surveys may indicate that the involvement of management in the implementation of an EMS at UTC facilities may have been a major contributing factor in the reduction of noncompliance events related to the labeling noncompliance category.

*management structure to address noncompliance and follow-through,”* while the specific contributing causes varied widely.

#### 4.4 Observations

Analysis of the noncompliance categories used for the pre- and post-EMS surveys reveals that O&M was the category of noncompliance most frequently identified (32 percent) in the pre-EMS profiles, while late or incomplete recordkeeping was the second most frequently identified category of noncompliance (16 percent). In the post-EMS profiles, late or incomplete recordkeeping (23 percent) was the most frequently cited category of noncompliance, followed closely by report submissions and reporting (21 percent), O&M (18 percent), and exceedances (17 percent).

In the pre-EMS surveys, **Management** was identified as the leading root cause of noncompliance for two of the top five noncompliance categories (O&M and labeling); for late or incomplete recordkeeping it was identified as the second

Aspects of **Management** (specific causes such as “*management support or guidance not provided*”, “*no formal management structure to address noncompliance and follow-through*”) appear to play a large role as a root cause of noncompliance prior to implementation of an EMS.

most common category after **Procedures**. In the post-EMS surveys, the distribution of categories of root causes of noncompliance was more variable. The most-commonly cited root cause categories in those surveys were **Human Error** and **Procedures**.

Section 5 below provides a more detailed comparison of the root and contributing causes of noncompliance identified in the pre- and post-EMS surveys. The next section also outlines the findings regarding the effect of the implementation of an EMS on the root cause of noncompliance.

## **5.0 COMPARISON OF ROOT AND CONTRIBUTING CAUSES OF NONCOMPLIANCE IN 1990 AND IN 1998 AND EFFECT OF THE IMPLEMENTATION OF AN EMS ON THE ROOT CAUSES OF NONCOMPLIANCE**

This section (1) summarizes the root and contributing causes of noncompliance, as identified by UTC, for noncompliance listed in the 1993 complaint and the 1998 third-party audits and (2) describes the effect that implementation of an EMS may have had on the root and contributing causes of noncompliance at the participating UTC facilities. This section begins with a description of limitations and qualifications for the data and ends with general observations related to the potential effect of the implementation of an EMS on the root and contributing causes of noncompliance.

### **5.1 Limitations and Qualifications**

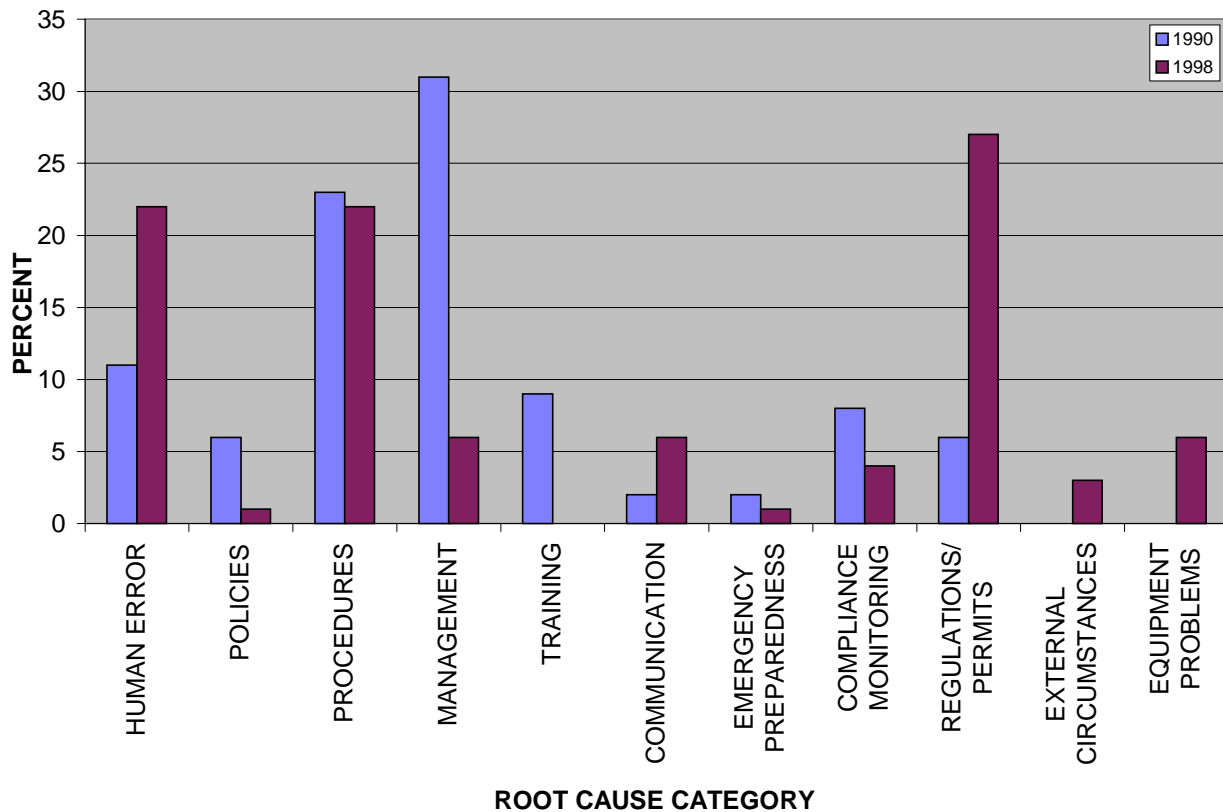
The conclusions that can be made are limited by the lack of availability of some personnel who have first-hand knowledge of practices at UTC facilities in 1990. The conclusions that can be drawn also may be limited by the limitations and qualifications presented in Section 4.1 of this document.

### **5.2 Root Causes**

Figure 9 allows comparison of the distribution of categories of root causes of noncompliance in 1990 with that in 1998. The most common categories of root causes of noncompliance identified by UTC for 1990 were (the number of times each root cause was identified is listed in parentheses):

- **Management** (69)
- **Procedures** (51)
- **Human Error** (23)

**Figure 9. Distribution of Root Causes of Noncompliance - 1990 vs. 1998**



The specific root causes of noncompliance identified most frequently in the pre-EMS surveys are (the number of times each root cause was identified is listed in parentheses):

- *No formal management structure to address noncompliance and follow-through (57)*
- *No written operating procedures available (19)*
- *Unavailable policy (12)*
- *Facility unaware of applicability of a regulation (10)*
- *Staffing - inappropriate level or expertise (7)*

Figure 9 shows that there were some major changes in root causes of noncompliance between 1990 and 1998. The lack of a formal management structure contributed greatly to the noncompliance events spelled out in the 1993 complaint. The figure shows the trend from the overall **Management** root cause to other possibly more intractable causes such as **Human Error**

and **Regulations and Permits**. In addition, the second and third most frequently cited specific root causes of noncompliance for 1990, (“*no written operating procedures available*” and “*unavailable policy*”) indicates the extent of absence of a systematic approach to complying with environmental requirements.

The categories of root causes of noncompliance most frequently identified by UTC in the post-EMS surveys are (the number of times each root cause category was identified is listed in parentheses):

- **Regulations and Permits** (38)
- **Human Error** (31)
- **Procedures** (31)

The specific root causes of noncompliance identified most frequently in the post-EMS surveys are (the number of times each root cause was identified is listed in parentheses):

- *Individual responsibility or professional judgment* (27)
- *Operating procedure not followed* (20)
- *Facility unaware of applicability of a regulation* (12)
- *Ambiguous state regulations* (7)
- *Inconsistent or contradictory interpretation of state regulations* (6)
- *Regulation deemed not applicable based on conversation with regulatory agency or facility interpretation; or position differs from regulatory agency or interpretation of requirement differs* (6)
- *Unavailable policy* (5)

The specific root cause indicating disagreements over interpretation of regulations within the prominent **Regulations and Permits** root cause category in the post-EMS surveys, indicates an awareness of the regulations on the part of UTC, but a potential lack of knowledge about how government

The factor that appears to play the most significant role with respect to noncompliance at UTC facilities in 1998 has to do with regulations and permits. That is, UTC staff were unaware of the applicability of a regulation, or there was disagreement between UTC personnel and EPA and state regulators about the interpretation of regulations.

officials apply or interpret and subsequently enforce such regulations. The number of times (12) that the root cause of noncompliance was the result of lack of knowledge of the applicability of a regulation may indicate the existence of a gap in the EMS, or it may reflect the time that it takes to implement all or a portion of an EMS.

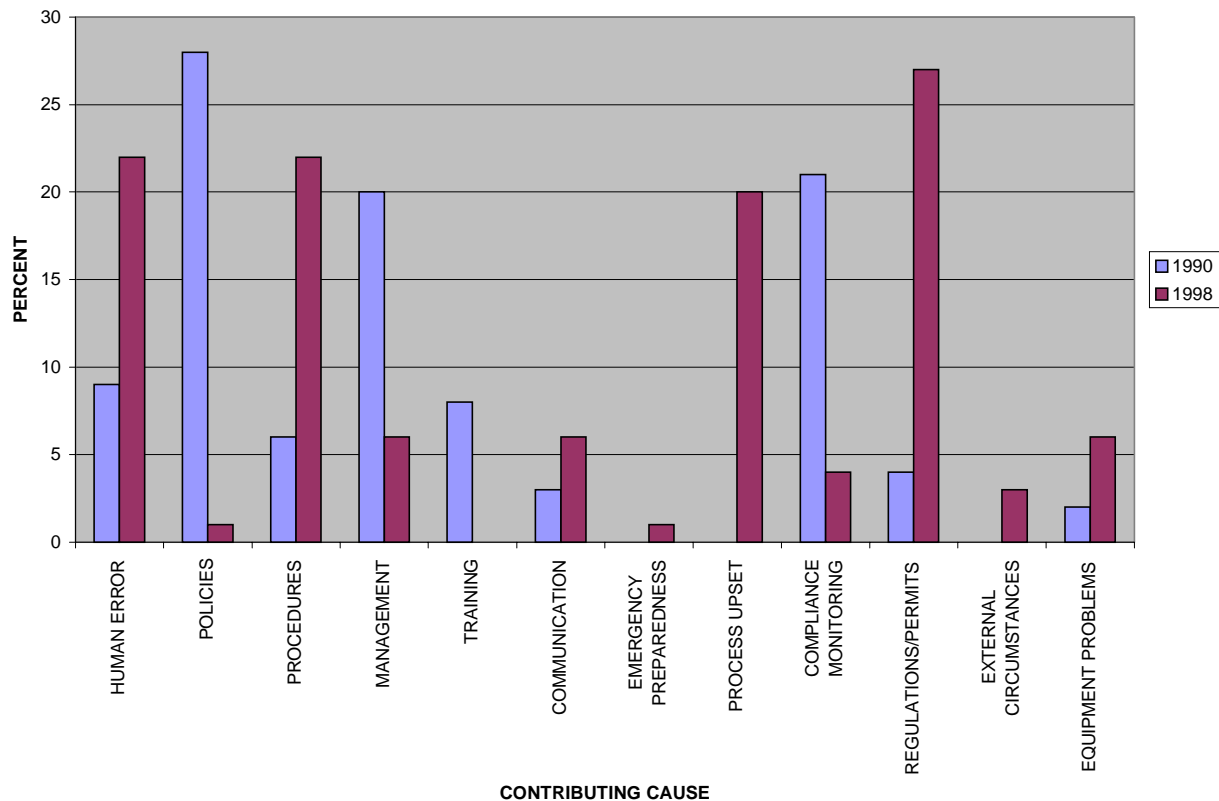
Analysis of the information presented above also indicates that the root cause of noncompliance in general has shifted from a lack of management systems toward other, possibly more intractable, factors, such as professional judgment and a failure to follow established procedures. When management is cited as the root cause of noncompliance reported in the post-EMS surveys, it appears more frequently to be the result of a lack of management oversight of individual employees than of the total absence of policies and procedures.

### **5.3 Contributing Causes**

Figure 10 allows comparison of contributing causes of noncompliance in 1990 and in 1998. The most common categories of contributing causes of noncompliance identified by UTC in the pre-EMS surveys are:

- **Policies (132)**
- **Compliance Monitoring (98)**
- **Management (92)**
- **Human Error (42)**

**Figure 10. Distribution of Contributing Causes of Noncompliance - 1990 vs. 1998**



The specific contributing causes of noncompliance most frequently identified in the pre-EMS surveys are (the number of times each contributing cause was identified is listed in parentheses):

- *Audit program insufficient (56)*
- *Routine site and equipment compliance checks not conducted (40)*
- *Inexperience, lack of knowledge, lack of technical expertise (29)*
- *Management support or guidance not provided (26)*
- *Staffing - inappropriate level or expertise (24)*
- *No written operating procedures available (17)*
- *Employee not trained (17)*
- *Management organization undefined (15)*
- *Training not available (14)*
- *Communication difficulties between management and employee (13)*
- *Environmental aspects of facility processes not identified (13)*

The most common categories of contributing causes of noncompliance identified by UTC in the post-EMS surveys include (the number of times each contributing cause was identified is listed in parentheses):

- **Procedures** (24)
- **Human Error** (20)
- **Compliance Monitoring** (15)

The specific contributing causes of noncompliance identified most frequently in the post-EMS surveys are (the number of times each contributing cause was identified is listed in parentheses):

- *Individual responsibility or professional judgment* (13)
- *Routine site and equipment compliance checks not conducted* (13)
- *Difficulty in relating operating procedures to actual facility operations and products* (11)
- *Staffing - inappropriate level or expertise* (7)
- *Environmental aspects of facility process and operations not identified* (7)
- *Operating procedure not followed* (5)

Based on the data presented above, it appears that two years after EMSs had been implemented at participating UTC facilities, contributing causes of noncompliance generally reflect issues of human error (professional judgment) and following and relating operating procedures to actual operations, rather than such issues as complete lack of management systems or oversight.

## **5.4 Observations**

The implementation of an EMS appears to have resulted in a general change in the types of root causes identified for noncompliance. In 1990, many of the root causes of noncompliance were related to **Management**: specifically, for example, “*no formal management structure to address noncompliance and follow-through*” existed to monitor and track compliance. Issues related to **Management** accounted for 31 percent of root causes of noncompliance in 1990; that number fell to 15 percent in 1998. Because all the participating facilities had implemented the vast majority of elements of an EMS by 1998, it appears that the implementation of an EMS helped to



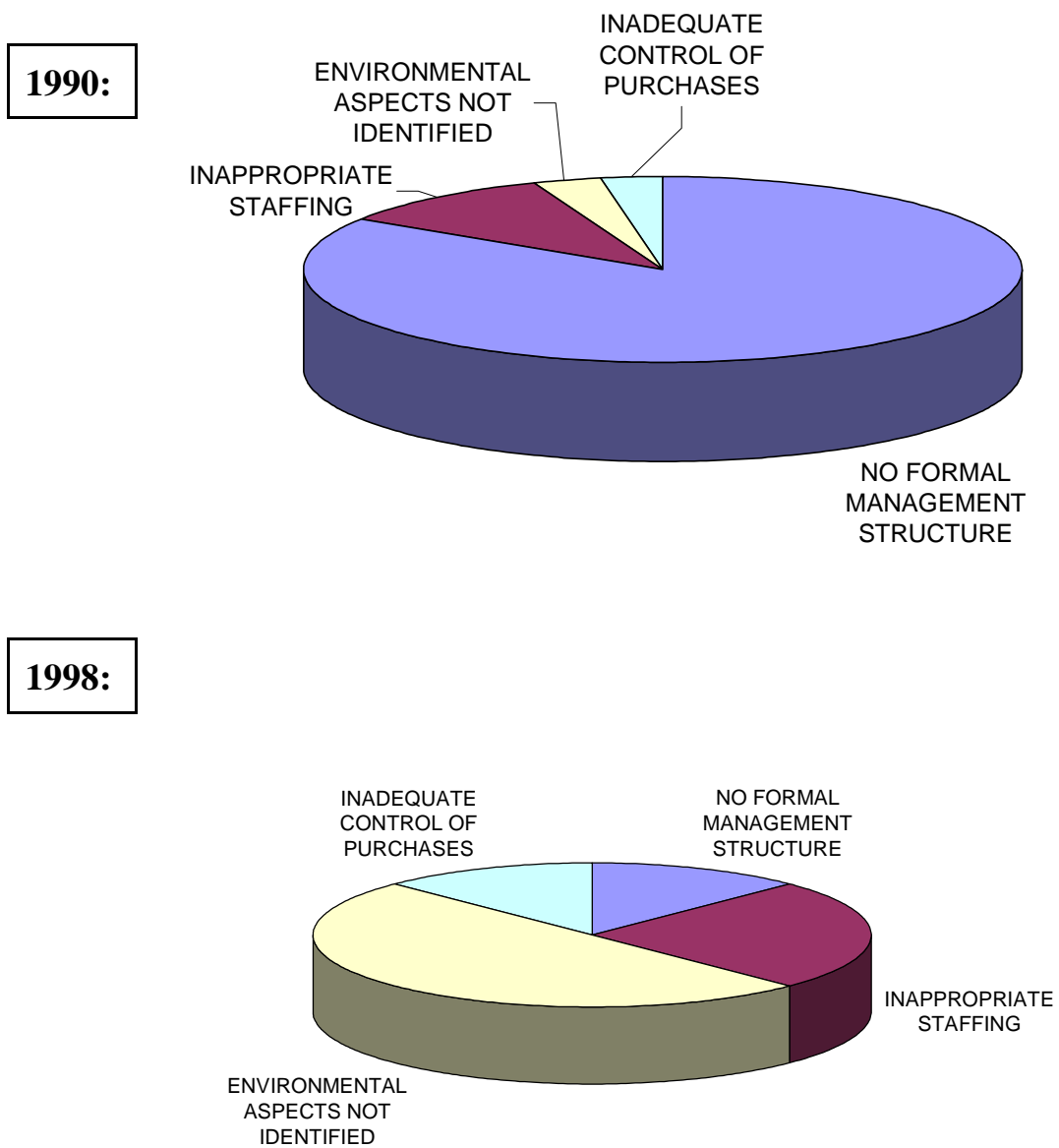
bring about a decrease of the number of instances of noncompliance that result from a lack of management controls and, in smaller and more focused areas in which corrective action was necessary to achieve compliance.

In the post-EMS surveys, the distribution of root causes identified had moved toward **Human Error** and failure to adhere to established **Policies** and **Procedures**. The responses to the post-EMS surveys indicate that, in most cases, a management structure had been established to communicate responsibilities related to environmental obligations, but that personnel assigned those responsibilities were not meeting them in all cases. That assertion is supported by the following data:

- Percentage of instances of noncompliance for which the root cause was **Human Error** climbed from 11 percent in 1990 to 19 percent in 1998.
- Although the percentage of instances of noncompliance attributed to **Procedures** remained nearly unchanged (23 percent in 1990 to 22 percent in 1998), examination of the specific causes of noncompliance shows that in the pre-EMS surveys the majority of the procedure-related incidents of noncompliance were the result of lack of procedures, and in the post-EMS surveys the majority of procedure-related incidents of noncompliance were the result of failure of personnel to comply with established procedures.

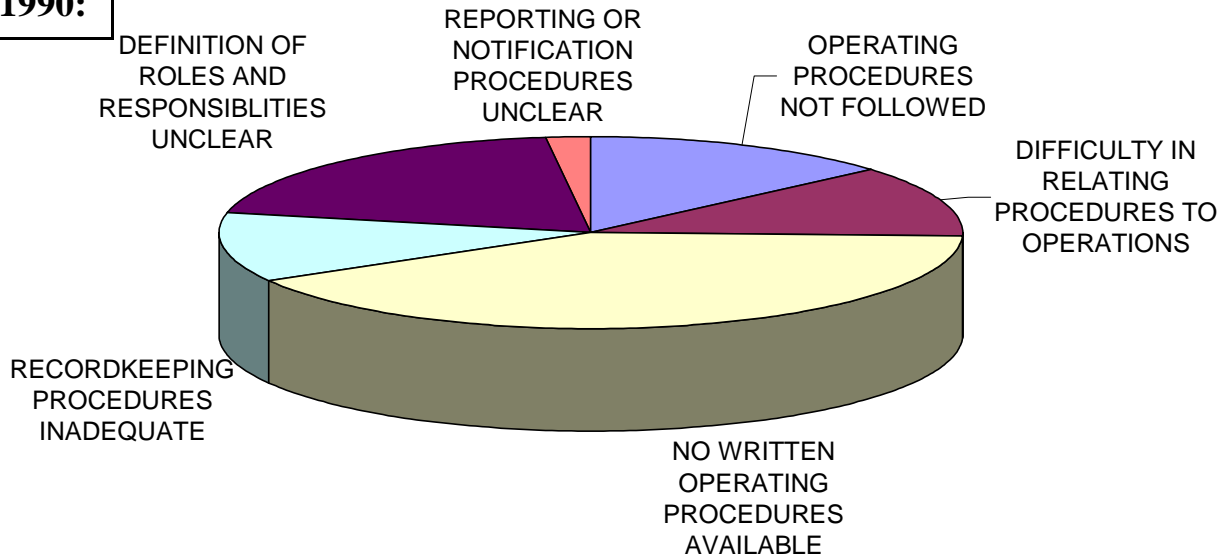
The change in root causes of noncompliance described above demonstrates that implementation of systems may be able to change the specific causes of noncompliance. Figures 11 and 12 show examples of the shift in distribution of root causes of noncompliance related to **Management** and **Procedures**.

**Figure 11. Distribution of Specific Management Root Causes - 1990 and 1998**

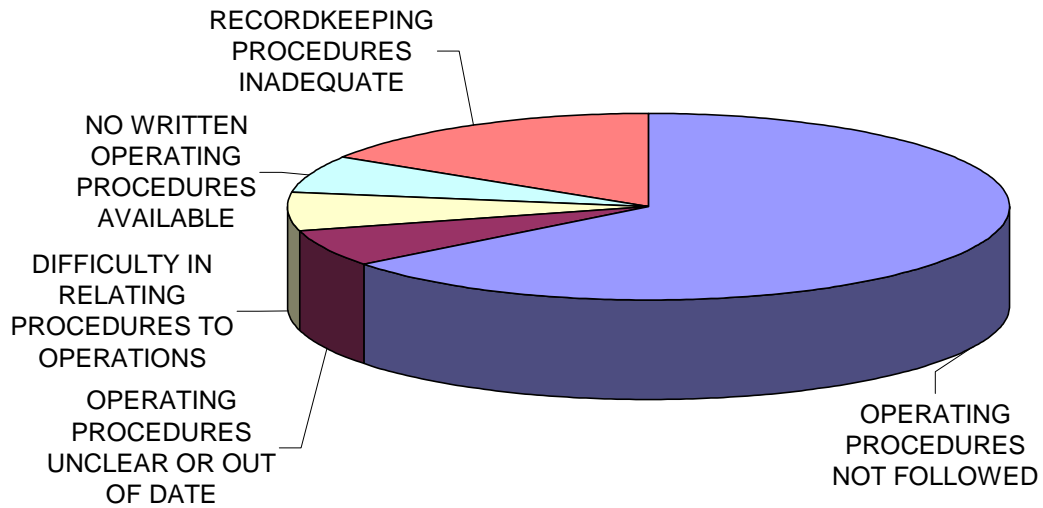


**Figure 12. Distribution of Specific Procedures Root Causes - 1990 and 1998**

**1990:**



**1998:**



## **6.0 EFFECT OF THE IMPLEMENTATION OF AN EMS ON COMPLIANCE**

This section describes the potential effect of the implementation of an EMS on compliance. The subsections below include (1) a discussion of limitations and qualifications related to the analysis of the effect an EMS has on compliance and (2) observations related to the potential effect of the implementation of an EMS on compliance.

### **6.1 Limitations and Qualifications**

The following limitations and qualifications restrict the types of findings this study can support with respect to the effect of implementation of an EMS on compliance:

- The analysis is limited because it is difficult to determine what caused a change in compliance rates: compliance with the terms of the consent decree or implementation of an EMS. For example, many corrective actions that involved modifications of wastewater treatment systems to achieve compliance with requirements of the CWA were mandated under the consent decree to which UTC was a signatory and the consent decree mandated the follow-up audits; thus it is difficult to assess the percentage of improvements in the compliance that could be attributed directly to implementation of an EMS.
- The analysis also must be qualified by the fact that the inspections conducted in the 1990 time frame were conducted for different purposes than the 1998 audits. Therefore, the two sets of inspections were not equivalent in terms of scope or duration.
- The information related to compliance during the 1998 time frame identifies instances of noncompliance with several statutes; however, only noncompliance with RCRA and the CWA were addressed in the 1993 complaint and subsequent profiles and pre-EMS surveys. Therefore, it is not meaningful to evaluate effects on compliance for statutes other than RCRA and the CWA.

## 6.2 Observations

In general, both the number of instances of noncompliance identified at each facility and the number of facilities having particular violations decreased between 1990 and 1998.

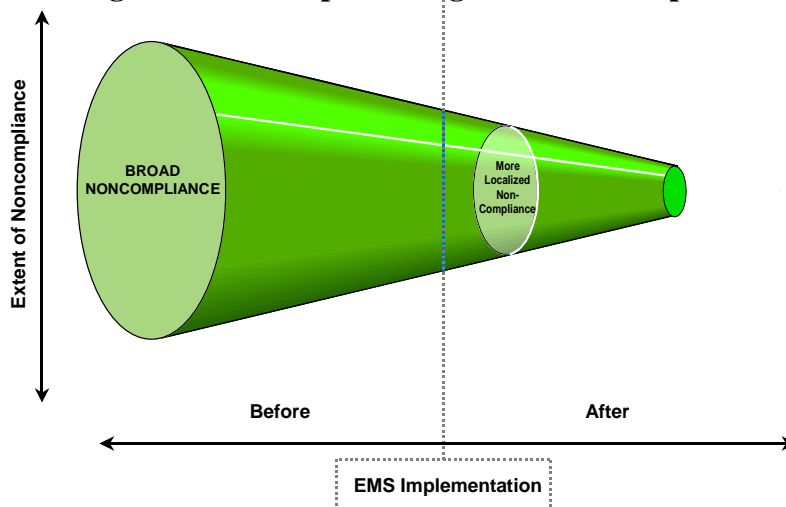
For example, although all six facilities inspected under RCRA were cited in 1990 for

failure to mark containers accumulating hazardous wastes with an initial accumulation date, only one of the eight facilities evaluated in this study was found in 1998 to be in violation of that requirement.

Based on the number of instances of noncompliance identified in 1990 and 1998, compliance at participating UTC facilities improved significantly with respect to noncompliance with specific requirements under RCRA and the CWA identified in the 1993 complaint.

Similarly, in the case of requirements for weekly inspections of hazardous waste accumulation areas, the complaint indicates that prior to EMS implementation, for many weeks there were no records of the facilities' performance of required self-inspections; indicating that the facilities routinely either failed to perform the inspections or failed to record their performance. However, in 1998, noncompliance associated with self-inspections generally included occasional failures to record some data on weekly inspection logs. Such improvements may be associated with the implementation of EMSs at UTC's participating facilities. Figure 13 provides a conceptual view of this progression.

**Figure 13. Conceptual Progression of Compliance**



Previous sections have outlined the trend shown in root causes of noncompliance, from (1) lack of management structure and oversight, and lack of operating procedures prior to EMS implementation to (2) human error and failure to follow established procedures after EMS implementation. The results of this study indicate that the implementation of EMSs and its associated structure and procedures may offer the advantage of helping a facility to focus on environmental compliance issues. This statement is based on a combination of the analysis of the root and contributing causes of noncompliance as well as improved compliance rates at participating UTC facilities, including both (1) fewer total instances of noncompliance at each facility, and (2) fewer facilities with individual instances of noncompliance. In addition, noncompliance that was identified during the 1998 audits typically was much less severe than that identified during the 1990 inspections. For example, the 1990 inspections found widespread noncompliance resulting in a consent decree and a multi-million dollar penalty. By contrast, a number of the instances of noncompliance identified during the 1998 audit were deemed sufficiently minor that no penalty was associated with them in the Report of Violations.

## **7.0 POLLUTION PREVENTION PRACTICES AT UTC FACILITIES**

This section describes the elements of a P2 program that were present at UTC facilities in 1990 and in 1998, as expressed by personnel of UTC facilities in response to the pre- and post-EMS surveys. In general, the use of the surveys was not effective in eliciting specific details about P2 projects implemented at participating UTC facilities. The elements of a P2 program agreed upon for this project are listed in Section 5 of the pre-EMS survey and Section 4 of the post-EMS survey (see Appendix B).

### **7.1 Limitations and Qualifications**

The responses presented in this section may be limited in their accuracy by the fact that the personnel completing the pre-EMS survey may not have had access to personnel who have first-hand knowledge of P2 practices in place at a facility in 1990. In addition, as discussed in greater